Forest Service

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File Code: **3410** **Date:** **March 17, 2021**

Subject: **Five Points Insect Report**

To: **Bill Gamble, La Grande District Ranger, Wallowa-Whitman NF**

Introduction

I conducted a reconnaissance within the Five Points Project accompanied by Lucas Glick on July 6th, 2020. I returned on July 7th and 8th and completed my site visit. My principal objectives were to assess 1) stand and site conditions, 2) activity of key pests, and 3) identify approaches, if needed, for maintaining or increasing vigor, resilience and resistance of host trees to damage and/or mortality from key pests.

Highlights

- Site productivity varies across the project area and is consistent with plant associations within dry, moist, and cold upland forest potential vegetation groups (Powell et al. 2007).
- Current estimates of stand density commonly exceed the lower limit of the self-thinning zone for the sites we encountered resulting in elevated moisture stress induced by competition.
- Existing vegetation has suffered additional moisture stress induced by protracted drought in recent years.
- Competition and drought induced moisture stress have predisposed grand fir and lodgepole pine to elevated risk of mortality caused by fir engraver, *Scolytus ventralis,* and mountain pine beetle, *Dendroctonus ponderosae*, respectively.
- Greater duration of water deficit and greater extremes in both temperature and precipitation during the period of water deficit are expected in the coming decades. Consequently, water supplying capacity of these sites is expected to diminish further.
- Reducing current moisture demand to a level consistent with the water supplying capacity of the site will help to mitigate competition induced moisture stress, moisture stress caused by infrequent periods of drought and predicted climatic conditions for the coming decades.
- Spacing leave trees to at least the lower limit of full site occupancy (Long,1985) and maintaining stand density below the zone of imminent competition mortality (Long 1985) will improve vigor of the leave trees and promote resilience and resistance to mortality agents and defoliators.
- Favoring a mix of nonhost species or nonhost and host species and maintaining even aged or single-story structures will reduce risk to defoliators.
- Favoring species employing a fire resister adaptation to frequent low to moderate fire intensity will further reduce risk to mortality agents under the climate conditions expected in the coming decades.

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Background

Current stand structure and species composition are, in part, a result of past fires, periods of drought, insect outbreaks, and silvicultural treatments. In turn, host vulnerability to fire and risk to key pests within, and in the vicinity of, the project area is a function of current stand structure and species composition.

Fire, as a disturbance agent, has had a reoccurring role in the vicinity of the project area (Fig. 1). Fires have been documented as early as 1800, 1903 and 1910. More recent fires have occurred in the 1970s, 1980s and 2000s. Fire within the project area has had a limited role. The Three Cabin Fire was the only fire document within the project area occurring in 1986 in the south end of the west block of the Project. Consequently, the absence of fire has allowed thin barked grand fir which employs a fire avoider adaptation to persist in sites supporting plant associations in the warm and moist upland forest potential vegetation groups.

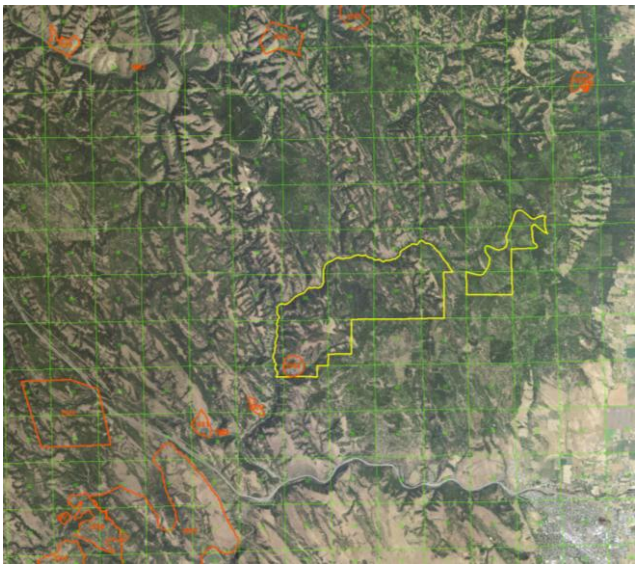

Figure 1 Distribution and extent of past fires in the vicinity of the Five Points Project

Periods of higher-intensity, protracted drought are evident from a review of the Palmer Drought Severity Index (PDSI) for Northeast Oregon (NOAA 2020). Recent periods of extended drought have occurred from: 1986-1994, 1999-2010, and 2011 to the present (Fig. 2).

Drought induced moisture stress increases host susceptibility to their associated key pests. Reduced moisture availability results in diminished photosynthetic capacity. Trees allocate photosynthate to their priorities in a particular hierarchy. When photosynthetic capacity is limited, insufficient photosynthate may be available for allocation to priorities lower in the hierarchy including production of secondary metabolites for preformed and induced resinous defenses.

Good water balance is also essential to maintain turgidity of resin cells surrounding resin canals. Turgid resin cells exert pressure on the oleoresin in the canals. Bark beetles that attack a host in good water balance sever resin canals and are ejected by the flow of oleoresin caused by the oleoresin exudation pressure (OEP) generated from turgid resin cells. Susceptibility of hosts to bark beetles does not necessarily end with the end of drought. Host trees may remain at elevated risk to bark beetles for a year or more following the end of a drought depending on the length of time it takes host trees to regain vigor.

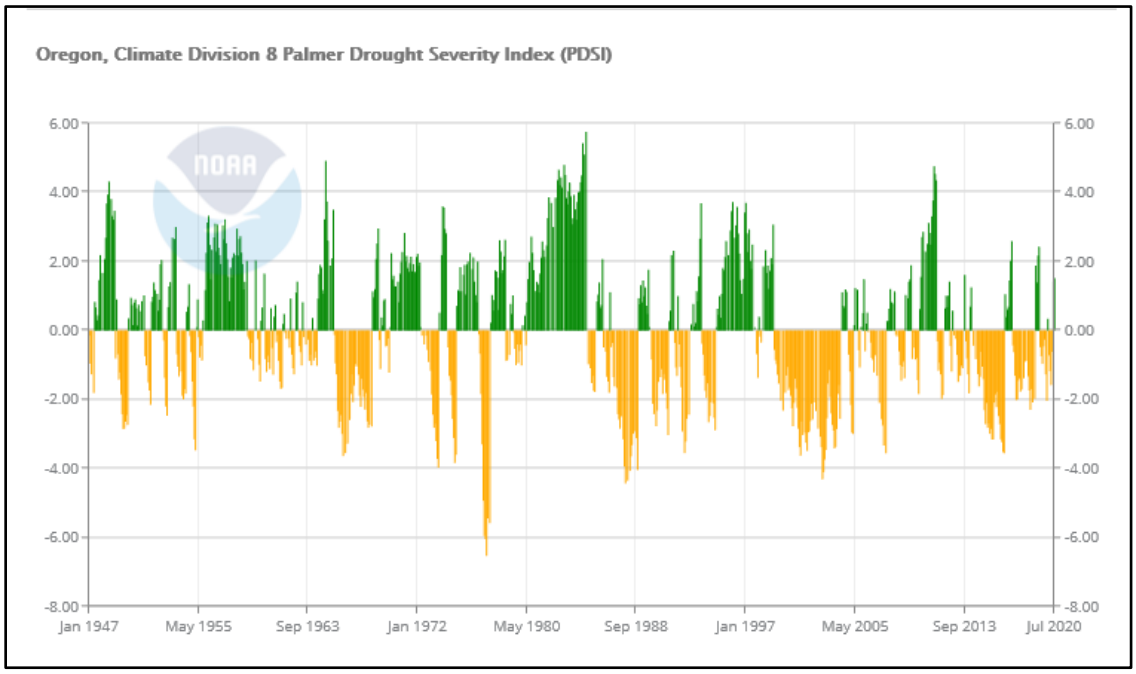

Figure 2) Palmer Drought Severity Index for Northeast Oregon from 1947 to 2020.

Insects have been active within, and proximate to, the project area. Insect and disease aerial detection survey sketch maps from 1947-2019 reveal that populations of western spruce budworm, *Choristoneura freemani*; balsam woolly adelgid, *Adelges piceae*; mountain pine beetle; and fir engraver beetles became elevated infrequently or periodically during that time frame. Populations of western spruce budworm became elevated in 1954-1957 and again in 1981-1991. Populations of balsam woolly adelgid were elevated from 2003-2015. Populations of mountain pine beetle became elevated from 1971-1980 and more recently from 2015-2019. Mountain pine beetle together with western pine beetle, *Dendroctonus brevicomis*, caused additional mortality of ponderosa pine during these time frames as well. Populations of fir engraver are currently elevated and have been so since 2018.

Stand structure and species composition have also been affected by silvicultural activities conducted within the project area. Several regeneration harvests were apparent from a review of color orthographic photos and evident during our site visit, particularly in the eastern block.

Project objectives, in part, are to reduce the risk or extent of, or increase the resilience to, insect infestation. Silvicultural treatment can be employed to obtain these objectives including promotion of stand structure consistent with both the water supplying capacity of the site and predicted climate change in the coming decades. Treatment that maintains stand density below the lower limit of the self-thinning zone can help mitigate loss of desired structure from key pests and fire. Promoting species that employ a fire resister adaptation to fire and reflect the historical range of variation can also help achieve these objectives.

Current conditions

Ponderosa pine series

Portions of the project area support plant associations in the ponderosa pine series. Many stands exhibit a stem exclusion stage of development. Older, larger diameter, pine commonly form a single-storied vertical structure and are largely uniform in distribution. Live crown ratios (LCRs) are somewhat reduced and stand density often exceeds the lower limit of the self-thinning zone. Recent western pine beetle and mountain pine beetle caused mortality of ponderosa pine was evident albeit infrequent.

Douglas-fir series

Other portions of the project area support plant associations within the Douglas-fir series. Vertical structure in these locations varies from single to two-storied. Older, larger diameter Douglas-fir and ponderosa pine occupy these sites. One or the other species dominates but species composition is more commonly a mix of both species. Grand fir is also present but limited to portions of the site with greater water supplying capacity, typically drainages. Horizontal structure varies from somewhat uniform to aggregated but commonly exceeds the lower limit of imminent competition mortality. Both Douglas-fir and ponderosa pine exhibit infestations of dwarf mistletoe that vary in extent and intensity.

Grand fir series

Still other portions of the project area support plant associations within the grand fir series. These areas exhibit a late to climax stage of successional development, and greater structural development with a range in diameters and vertical structure. Our estimates of stand density commonly exceed the lower limit of the self-thinning zone approximated by the upper limit of the management zone (ULMZ) (Powell 1999) and often exceeded full stocking resulting in elevated moisture stress induced by competition.

Absence of fire has allowed thin-barked species (grand fir, Engelmann spruce, and subalpine fir) to persist in these locations. These stands exhibit a two to multi-storied vertical structure where shade-tolerant late-seral and climax species often dominate.

Subalpine fir contributed more substantially to the species composition in the past. However, the current component of subalpine fir has been significantly reduced due to mortality of host trees caused by balsam woolly adelgid in recent years. Many of the remaining subalpine fir exhibit severe infestations and damage from balsam woolly adelgid.

Western larch contributes to species diversity in some locations and dominates the overstory in places. In some locations, dwarf mistletoe infections in western larch are severe, exhibiting 5 and 6 class dwarf mistletoe ratings. Dwarf mistletoe infections of western larch are notably absent in other locations.

Ponderosa pine also contributes to species composition in these locations, albeit to a lesser extent. An undetermined species of pine needleminer, likely *Coleotechnites sp*., was observed damaging ponderosa pine in some locations. Conditions have favored a buildup in populations of this pest in 2020. However, activity of pine needleminer in this project is not at the intensity or magnitude observed in other project areas, notably the Baker Watershed.

Young stands

The project area also encompasses younger, smaller diameter, stands particularly within the moist upland forest potential vegetation group. An overstory component is absent in some of these locations. In other locations, the number and distribution of overstory trees suggest a seed tree or shelterwood method was employed to regenerate these sites. In still other locations an understory component has established below a uniformly distributed overstory.

Composition of existing vegetation varies substantially between and within plantations. Some areas are dominated by western larch, lodgepole pine, or a mix of both species. Other areas exhibit greater diversity of species including lodgepole pine, ponderosa pine, western white pine, western larch, Douglas-fir, subalpine fir, Engelmann spruce, and grand fir.

Plantations typically exhibit dense horizontal structure. Crown expansion has become restricted in numerous locations resulting in limited crown widths. Shading of lower crowns has caused reduction in live crown ratios (LCRs).

Activity by several key pests was evident in the young stands I visited. White pine blister rust has killed, and currently infects western white pine in limited locations. Infestations of balsam woolly adelgid have killed many subalpine firs in recent years and current infestations of remaining fir are often severe. Fir engraver caused mortality of grand fir continues infrequently throughout the younger stands. Western larch in the vicinity of overstory larch with dwarf mistletoe infections have become infected with dwarf mistletoe as well. Limited dwarf mistletoe infections of Douglas-fir in the understory was also evident.

Key pests

Fir engraver beetle

Grand fir and white fir are primary hosts for fir engraver. Subalpine fir is an occasional host of fir engraver. Fir engraver utilizes host material in the form of standing green trees, cut logs or recent wind throw (Ferrell 1986).

Conifers employ both preformed and induced defenses against key bark beetle pests. Douglas-fir, western larch, Engelmann spruce, and pines utilize preformed resin canals. By way of contrast, the preformed resinous defenses of true firs consist of pitch blisters located in the outer cortex of the bark. Preformed resinous defenses in true firs are not very effective at inhibiting damage from fir engraver beetles. Fir engraver beetles arriving at their hosts rarely sever existing resin-containing ovoid blisters (Berryman 1969). Moreover, beetles that succeed in reaching the inner bark are no longer at risk of encountering pitch blisters located in the outer cortex.

Induced defenses are the primary means by which true firs are able to resist attack from fir engraver beetles. Host trees are stimulated to produce oleoresin in response to egg gallery construction by adult female beetles (Lieutier 2002). Vigorous hosts can rapidly produce a sufficient volume of oleoresin to expel attacking beetles. Less vigorous individuals induce resinous defenses more slowly. Consequently, female beetles may complete egg gallery construction and oviposition without being ejected by oleoresin. However, less vigorous hosts may still be able to produce sufficient oleoresin to surround the egg galleries, suffocate the eggs and/or inhibit larval development. Nonvigorous hosts have insufficient carbohydrate reserves to induce resin production and eject incoming beetles. Invading beetles are successful in these hosts. Progeny are also successful. By sheer numbers, incoming beetles and their progeny can overcome host defenses and cause mortality.

Pioneering individuals of some bark beetles species distinguish, and preferentially attack, weakened hosts based on olfactory cues consisting of host volatiles in combination with ethanol. Pioneering beetles then release aggregant pheromones that, in combination with host volatiles, attract additional conspecific beetles. Fir engraver beetles, by way of contrast, select host trees based on host volatiles alone (Macias-Somano et al. 1998). Moreover, weakened hosts may be more attractive to fir engraver than vigorous hosts based on differences in host volatile constituents and/or their concentrations (Macias-Somano et al. 1998). Ethanol and long distance aggregant pheromones, however, do not appear to play a role in fir engraver host selection (Macias-Somano et al. 1998).

Both vigorous and weakened hosts are attacked by fir engraver (Struble 1937, Ferrell 1986). Attacks by fir engraver beetles in vigorous hosts are often limited to strip kills. Necrotic patches are subsequently occluded by callus tissue. Consequently, host mortality under endemic conditions is often limited to few and scattered individuals stressed by competition or weakened by root disease.

Outbreaks of fir engraver are favored by conditions that lower the resistance of host trees. The 1974-1976 outbreak in the Blue Mountains was associated with an outbreak of defoliators (Ferrell 1986). Other outbreaks have been associated with drought (Ferrell 1991).

Drought has occurred repeatedly at this location (Fig. 2). Elevated levels of grand fir mortality caused by fir engraver are associated with these periods of intense protracted drought (Fig. 3). The most recent period of drought associated with the project area began in 2011. Protracted drought in association with competition induced moisture stress has increased the number of susceptible hosts. During protracted drought, the likelihood of encountering susceptible hosts increases while more and more progeny are successful. This was reflected by the aerial insect and disease survey for Oregon and Washington in 2018-2019 (ADS 1947-present) which showed elevated levels of fir engraver mortality across the Blue Mountains.

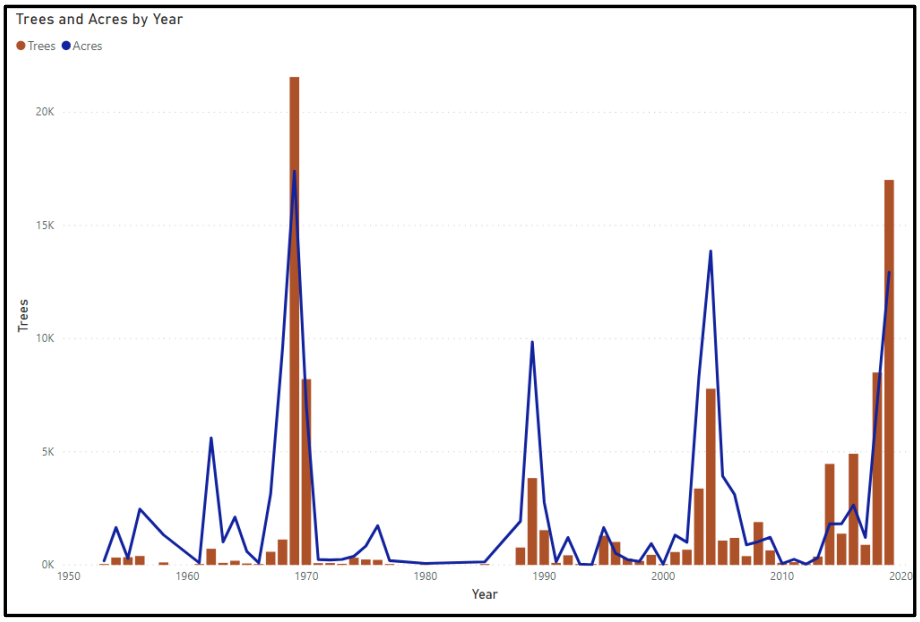

Figure 3) Fir engraver caused tree mortality and acres affected in the La Grande RD from 1947-present

Mountain pine beetle

Outbreaks of mountain pine beetle in stands of lodgepole pine characteristically develop and are sustained in stands greater than 80 years old, with an average tree diameter greater than 8 inches DBH, over 100 sq. ft. of basal area per acre and generally between 300-600 trees per acre (Gibson et al. 2009). In part, shade intolerant lodgepole pine growing at these densities and length of time have developed reduced live crown ratios (LCRs) due to competition for light, which in turn limits photosynthetic capacity. Competition for limited soil moisture further limits photosynthetic capacity with the result that trees are challenged to produce sufficient photosynthate for production of secondary

metabolites for defense. In addition, stands with trees of these diameters provide abundant hosts with phloem of sufficient thickness to support brood development.

Additional moisture stress has resulted from recent drought conditions that began in 2011. Moisture stress due to both competition and drought have further predisposed lodgepole pine to mortality from mountain pine beetle.

Western spruce budworm and Douglas-fir tussock moth

Current damage by western spruce budworm or Douglas-fir tussock moth, *Orgyia pseudotsugata*, was not observed at the time of our reconnaissance. However, these defoliators can increase to outbreak levels and cause significant damage to host species across the landscape. Review of the aerial insect and disease survey for Oregon and Washington revealed that outbreaks of western spruce budworm encompassing, or in the vicinity of, the project area occurred between 1954-1957 and 1981-1991(ADS 1947-present).

Douglas-fir tussock moth is a key defoliator that periodically increases to outbreak levels roughly every 7 to 11 years. Recent outbreaks of Douglas-fir tussock moth in Region 6 have occurred in NE Oregon in 1972-1974 and 1999-2000. In fact, portions of the Malheur and Wallowa-Whitman National Forests are currently experiencing defoliation by Douglas-fir tussock moth synchronous with outbreaks in North Central Washington (ADS 1947-present) and Idaho (Tom Eckberg, personal communication).

Mid-to-late successional layer types are at greater susceptibility to these two defoliators. In part, this is because host trees are a major component of the stands in contrast to early successional layer types dominated by non-hosts or a mix of host and nonhost species (Clausnitzer 1993). However, successional status alone is insufficient to inform management strategies designed to increase resistance to key pests. Species composition interacts with stand structure, particularly horizontal structure, and must be considered when developing management strategies (Clausnitzer 1993). In the case of these defoliators, vertical structure can also be important.

Western spruce budworm is favored by stands dominated primarily by host species including true firs, Engelmann spruce, Douglas-fir, and western larch because, in part, they are more likely to encounter a host species during dispersal. Western spruce budworm larvae emerge from eggs in late summer/early fall. First instar larvae seek out protected places in bark fissures or bark furrows or under lichen or moss. Larvae construct silken shelters, hibernacula, under which they overwinter as second instar larvae. Caterpillars emerge from their hibernacula in the spring with warming temperatures. Larvae crawl up the bole and out along the branches. Caterpillars then suspend from the foliage of their host trees by a silken thread produced from a silk gland in their mouth. When the thread is severed from the branch, it acts as a sail and allows the larvae to disperse by wind, or “balloon”, from their current location to foliage lower in the crown of the same host or to new hosts. Consequently, larvae are favored by dense

stand structures primarily dominated by host trees. Ballooning larvae are more likely to be captured by host trees under these conditions than in more open stands (Fellin and Dewey 1986). Western spruce budworm is also favored by two-storied to multi-storied stand structures with host in the overstory and understory (Fellin and Dewey 1986). Larvae eventually balloon downward where they are captured by shade tolerant preferred hosts in the understory (Brookes et al. 1987). Douglas-fir tussock moth first instar larvae emerge from eggs in the spring and, like the western spruce budworm, disperse via ballooning. Dispersal, therefore, is favored by similar stand structures (Brookes et al. 1978).

Pine Needleminer

Pine needleminer, *Coleotechnites sp*., was active in ponderosa pine on sites within the eastern block. Larvae mine pine needles reducing photosynthetic capacity and allocations of photosynthate to production of secondary metabolites for defense. Pine needleminer populations were elevated in other areas within the Wallowa-Whitman NF in 2020, particularly the Baker Watershed (Lia Spiegel, personal communication).

Climate

Walter climate diagrams compare seasonal relationships between precipitation and temperature for the Five Points Project (see Appendix). The diagrams enable biologically meaningful comparisons of these two interacting components of climate which are expected to change relative to “normal” (1950-2000) or baseline climate of the recent past. The relationship between temperature and precipitation in the coming decades consistently diverges from baseline patterns with important implications to forest health.

Length and magnitude of the seasonal water deficit are expected to increase. Accordingly, the growing season is expected to become hotter, drier, and longer. Precipitation during the water surplus period is expected to increase. However, precipitation during this period is more likely to be received under warmer temperatures, as rain instead of snow. Moreover, snow that does accumulate and contribute to the snowpack has a greater likelihood of melting during predicted periods of winter warming. Reduced snowpack will further exacerbate the moisture stress trees experience during the longer, drier, growing season.

Given the predicted divergence from baseline climate patterns of the recent past, the water supplying capacity and, accordingly, the carrying capacity of the sites we visited is expected to diminish in the coming decades. The lower limit of full site occupancy as well as the zone of imminent competition mortality will likely be lower, reflecting predicted changes in temperature and precipitation in the coming decades.

Under greater competition for declining soil moisture, the ability of trees to resist bark beetle attacks will be reduced. Tree mortality will likely increase due to lower available soil moisture during the growing season. Moreover, the fire regime will likely become more frequent and severe. Year-to-year variability in monthly temperature and precipitation is also projected to increase significantly in the decades to come. Climate changes over the next several decades are likely to alter site potential within the project area.

In view of the expected changes in climate, treatments to reduce moisture stress due to both competition and reduced moisture availability in this area may require greater reductions of stand densities, i.e. wider spacing, to keep soil moisture demand in sync with the expected reduction in water supplying capacity of the site.

Recommendations

Without silvicultural treatment

Stand density is already greater than the lower limit of the self-thinning zone over much of the project area we visited. Portions of the project area even exceeded full stocking. Stand density will continue to increase in the coming years. Accordingly, competition for limited soil moisture will become even greater. Photosynthetic capacity of individual trees will be compromised and allocations of carbohydrates to production of secondary metabolites for preformed and induced resinous defenses against mortality agents will be impacted. Moreover, host trees not in good water balance are unable to maintain resin cells with sufficient turgor pressure to cause the exudation of oleoresin from preformed resin canals and eject attacking bark beetles.

Current and continued periods of drought along with predicted increases in temperature and decreases in precipitation over longer periods of water deficit are expected to further elevate the susceptibility of host trees to their associated mortality agents at this location in the coming decades. In addition, the increase in stand density in a two to multi-storied vertical structure composed primarily of host for western spruce budworm and/or Douglas-fir tussock moth increases the likelihood that ballooning larvae are captured by host species. Under these conditions, the intensity and duration of outbreaks are likely to increase, when they occur, along with elevated damage to host trees from these defoliators. Moreover, hosts impacted by these defoliators are at elevated susceptibility to their associated bark beetles.

Susceptibility of lodgepole pine, to mountain pine beetle; Ponderosa pine to pine beetles; subalpine fir to balsam wooly adelgid; grand fir to fir engraver; and grand fir, subalpine fir, Engelmann spruce, and western larch to western spruce budworm and Douglas-fir tussock moth will likely become even more elevated with potential loss of both desired structure and function.

With silvicultural treatment

Ponderosa pine series

Reducing competition induced moisture stress can improve resistance to mountain pine beetles and western pine beetles. This approach can be accomplished by thinning from below and spacing dominant and codominant leave trees to at least the lower limit of full site occupancy (Long 1985). Moisture stress is further exacerbated by current droughty conditions. Periods of drought are a common occurrence historically and are likely to continue in the future. Together with predicted change in climate in the coming decades, an alternative approach would be to reduce moisture demand still further in keeping with the diminished water supplying capacity in these locations. One strategy would be to reduce stocking to the lower limit of full site occupancy for the next dryer plant association.

Ponderosa pine is well suited for retention in these sites. Trees develop thick bark and high crowns over time, adaptions that facilitate resistance to more frequent fire events expected in association with predicted climate change. In addition, ponderosa pine trees have deep moisture gathering roots that can access moisture in the interstitial regions of the bedrock unavailable to other trees and subordinate vegetation, i.e. grasses, with shallow moisture gathering roots confined to the upper horizons of the soil. This allows ponderosa pine to compete effectively for limited moisture with grasses on harsh sites.

Douglas-fir series

The same strategy for reducing moisture demand/moisture stress identified for sites supporting plant associations in the ponderosa pine series can be utilized for plant associations in the Douglas-fir series. Current stands can be thinned from below, spacing dominant and codominant leave trees to at least the lower limit of full site occupancy associated with the current, or even next dryer, plant association. This approach can improve vigor and increase resilience and resistance of retained individuals to their associated mortality agents by reducing competition induced moisture stress, current drought induced moisture stress, expected future periods of drought and climate change.

Thinning from below has the added benefit of maintaining even-aged stands in a single-storied structure and converting stands currently in a two-storied structure to a single-storied structure. Both ponderosa pine and Douglas-fir employ a resister adaptation to fire and are suitable candidates for retention in these sites. However, ponderosa pine can be favored for retention over Douglas-fir due to their deep moisture gathering roots. This ecophysiological adaption gives ponderosa pine a competitive advantage over Douglas-fir and facilitates maintenance of vigor under predicted climate change in the coming decades. Where ponderosa pine is absent, Douglas-fir can be favored for retention. Drainages with greater water supplying capacity currently support grand fir. In

the coming decades, water supplying capacity is expected to diminish and so ponderosa pine and Douglas-fir are appropriate species for retention in these locations to reduce moisture stress.

Grand fir series

Stands occupying sites supporting plant associations in the grand fir series can be thinned from below. Dominant and codominant leave trees can be spaced to at least the lower limit of full site occupancy associated with the current, or even next dryer, plant association to reduce moisture stress due to competition. These sites support western larch in addition to ponderosa pine and Douglas-fir, another species that employs a resister adaptation to fire. These species are particularly well suited for future conditions and therefore appropriate candidates for retention. Western larch like ponderosa pine and Douglas-fir develops, over time, bark thick enough to protect the cambium at the base and along the bole of the tree from being killed by the heat generated during low intensity fires (Starker 1934). Western larch also develops high crowns, effectively reducing fuel ladders (Starker 1934).

True firs and Engelmann spruce, on the other hand, employ an avoider adaption to fire (Rowe 1983). Retained individuals would still be at elevated risk of mortality caused by fire following treatment. Young thin-barked individuals are readily killed by fire. Older grand fir develops bark of moderate thickness (Starker 1934) and may survive light surface fires.

Grand fir is most commonly killed when subjected to root charring or crown fires (Starker 1934). Grand fir exhibits a shallow rooting habit (Starker 1934). Ground fires can injure shallow roots. Consequently, even mature trees can be killed (Howard and Aleksoff 2000).

Grand fir does not survive crowning or severe fire (Howard and Aleksoff 2000). Grand fir is characterized by a low, dense branching habit and flammable foliage. These ladder fuels increase the likelihood of torching and mortality (Howard and Aleksoff 2000). Under dense stand conditions with contiguous aerial fuels, crown fire is also more likely to occur.

Subalpine fir is another species that employs an avoider adaptation to fire. This thin-barked species is not likely to persist in the face of more frequent wildland and prescribed fires in the coming decades. For this reason, it is unsuitable as a candidate for retention. Furthermore, many of the subalpine fir have been killed in recent years by balsam woolly adelgid and many of the remaining individuals are unsuitable candidates for retention as they exhibit current and severe infections of balsam woolly adelgid.

One or more of the early and/or mid-seral species in combination are typically available and suitable for retention to address more frequent fire associated with expected climate

change in the coming decades. Susceptibility of host trees to fir engraver would be significantly reduced, in part, due to the reduction in the percent of host available, the retention of vigorous hosts, and reduction in competition for moisture. Retaining a mix of early and mid-seral species further reduces risk to mortality agents as the abundance of hosts for any one key pest are reduced.

Grand fir plant associations in a late to climax successional stage are at greater risk to defoliators such as western spruce budworm and/or Douglas-fir tussock moth. In part, there is a greater abundance of hosts. In addition, the dense two to multi-storied vertical structure facilitates the survival of wind dispersed larvae. Where a sufficient number of early to mid-seral species are available, silvicultural treatment will result in a shift from a mid to late-climax stage of development to an early to mid-seral stage of development. Thinning from below converts these two-storied to multi-storied structures to single-storied stands. The combination of increasing the distance between hosts by spacing leave trees and retaining a mix of hosts and non-hosts or favoring nonhosts in the upper stratum, together with eliminating preferred hosts in the lower strata, increases the likelihood of loss of “ballooning” larvae which either starve or are eaten by ants and beetles or other predators. Incorporation of prescribed fire to remove ingrowth at appropriate time intervals can be employed to maintain the single-story structure.

In some locations, there are an insufficient number and distribution of suitable early to mid-seral species for retention. In these areas, larger openings can be created to provide sufficient growing space, in terms of light, to promote regeneration of shade intolerant ponderosa pine and western larch. Prescribed fire can be employed to remove duff/litter and expose mineral soil to form a suitable seedbed. Timing prescribed fire to take advantage of good seed years can be challenging so artificial regeneration could be employed if necessary.

Young stands

Current stands can be thinned from below, spacing dominant and codominant leave trees to at least the lower limit of full site occupancy associated with the current, or even next dryer, plant association. This approach can improve vigor and increase resilience and resistance of retained individuals to their associated mortality agents by reducing competition induced moisture stress, current drought induced moisture stress, expected future periods of drought and climate change.

Spacing leave trees also increases physical growing space, promoting the development of increased crown widths and live crown ratios. With increased photosynthetic surface area comes increased photosynthetic capacity. Free growing trees are better able to allocate photosynthate to priorities lower in the hierarchy including production of secondary metabolites for defense against mortality agents.

Species composition is quite variable between plantations. In some locations, the only species to retain is lodgepole pine. Lodgepole pine stands at elevated risk to mountain

pine beetle are typically 80 years of age or older with a quadratic mean diameter of 8 inches DBH or greater and 300-600 trees per acre. One plantation I encountered was less than 80 years of age, less than 8 inches in QMD, and in excess of 600 TPA. While this stand is not currently at elevated risk to mountain pine beetle, treatment is needed to maintain or improve LCRs and reduce moisture stress moving forward. Spacing dominant trees to the lower limit of full site occupancy or less will result in a QMD of leave trees at, or slightly above, 8 inches DBH and a density of less than 300 TPA. Retained dominant trees will have sufficient LCRs to occupy released growing space and improve in vigor and resistance to mountain pine beetle with time. Lodgepole pine, however, has thin bark and is not likely to persist with more frequent fires expected in the coming decades.

Other stands are almost an equal mix of lodgepole pine and western larch or western larch alone. Where western larch and lodgepole pine are competing equally, a roughly equal mix of both species can be retained. Alternatively, western larch can be favored to promote both resistance to more frequent low intensity fires in the coming decades as well as resistance to key pests.

Still other locations have a greater mix of species. Retention of fire resister species including ponderosa pine, western larch, and/or Douglas-fir will promote resistance to more frequent low intensity fires and promote resistance to mortality agents and defoliators by reducing the component of host for any one pest should conditions favor buildup of populations.

Western white pine is a component of some stands. Where WPBR is active, western white pine should be removed. Where western white pines are free of WPBR infections, this species can be added to the mix of retained individuals.

Some locations have an overstory component. In portions of these stands, overstory is heavily infected with dwarf mistletoe. Understory trees of the same species are already becoming infected with dwarf mistletoe seeds dispersed from the upper stratum. Girdling of dwarf mistletoe infected overstory trees will facilitate vigorous growth of spaced understory trees of the same species. In other locations, different species of fire resister species are present below dwarf mistletoe infected overstory trees. These species can be favored for retention and promote resilience and resistance to their associated mortality agents.

In other locations, an understory component has developed under a previously spaced older even-aged structure. The understory is currently competing for growing space with the overstory and developing into fire ladders. In these situations, removal of the understory will maintain/promote vigorous growth of the previously treated older stand.

Please feel free to contact me if you have any questions.

/s/Mike Johnson
MIKE JOHNSON
Forest Entomologist

Cc: Roy Cuzick, Lucas Glick, James Brammer, Lia Spiegel, Michael McWilliams

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Appendix

Walter Climate Diagrams for the Five Points Project Area